

The invention claimed is:

1. A method of producing a metal component from a liquid metal alloy composition, comprising:
 - forming a liquid metal alloy composition that is free of solid material;
 - positioning a quantity of the liquid metal alloy composition in a holding vessel;
 - inserting a graphite agitator into the liquid metal alloy composition in the holding vessel;
 - agitating the liquid metal alloy composition with the graphite agitator while cooling the metal alloy composition to initiate solidification and form a non-dendritic semi-solid slurry;
 - ceasing agitation and removing the graphite agitator from the non-dendritic semi-solid slurry after the solids content of the slurry has risen to a value of from about 1% to about 20% by weight;
 - cooling the non-dendritic semi-solid slurry without agitation until the solids content has risen to a value of from about 10% to about 65%; and
 - transferring the non-dendritic semi-solid slurry having a solids content of from about 10% to about 65% to a component forming apparatus and shaping the transferred material into a desired metal component.
2. The method of claim 1, wherein cooling of the non-dendritic semi-solid slurry is achieved by transferring the non-dendritic semi-solid slurry having a solids content of from about 1% to about 20% by weight to a cooling vessel, and cooling the slurry in the cooling vessel.
3. The method of claim 2, wherein the cooling vessel has walls made of a material selected from steel and stainless steel.
4. The method of claim 2, wherein the cooling vessel has walls made of graphite.
5. The method of claim 2, wherein air is blown along the walls of the cooling vessel.

6. The method of claim 3, wherein the internal walls of the cooling vessel are provided with a non-wetting or reduced wetting coating.
7. The method of claim 6, wherein the coating is a boron nitride coating.
8. The method of claims 1, wherein the liquid metal alloy composition is agitated for a predetermined duration based on the initial temperature of the metal alloy composition and the heat extraction rate of the agitator.
9. An apparatus for direct production of a non-dendritic, semi-solid metal alloy slurry from a liquid state for subsequent forming into a metal component, comprising:
 - a vessel for containing a metal alloy composition; and
 - a graphite agitator for inducing convection while rapidly cooling said metal composition to initiate solidification and forming non-dendritic solid particles in the metal alloy composition.
10. The apparatus of claim 9, further comprising a separate cooling vessel.
11. The apparatus of claim 10, wherein the cooling vessel has walls made of a material selected from steel and stainless steel.
12. The apparatus of claim 10, wherein the cooling vessel has walls made of graphite.
13. The apparatus of claim 11, wherein the internal walls of the cooling vessel are provided with a non-wetting or reduced wetting coating.
14. The apparatus of claim 13, wherein the coating is a boron nitride coating.

15. A method of producing a metal component from a liquid metal alloy composition, comprising:

- forming a liquid metal alloy composition that is free of solid material;
- transferring a quantity of the liquid metal alloy composition to a holding vessel;
- inserting an agitator into the liquid metal alloy composition in the holding vessel;
- agitating the liquid metal alloy composition in the holding vessel with an agitator while cooling the liquid metal alloy composition in the holding vessel to initiate solidification and form a non-dendritic semi-solid slurry;
- ceasing agitation and removing the agitator from the non-dendritic semi-solid slurry after the solids content has risen to a value of from about 1% to about 20% by weight;
- transferring the slurry having a solids content of from about 1% to about 20% by weight to a cooling vessel and cooling the slurry without agitation until the solids content has risen to a value of from about 10% to about 65% by weight; and
- transferring the non-dendritic semi-solid slurry having a solids content of from about 10% to about 65% to a component forming apparatus and shaping the transferred material into a desired metal component.

16. The method of claim 15, wherein the cooling vessel has walls made of a material selected from steel and stainless steel.

17. The method of claim 15, wherein the cooling vessel has walls made of graphite.

18. The method of claim 15, wherein air is blown along the walls of the cooling vessel.

19. The method of claim 16, wherein the internal walls of the cooling vessel are provided with a non-wetting or reduced wetting coating.

20. The method of claim 19, wherein the coating is a boron nitride coating.
21. The method of claims 15, wherein the liquid metal alloy composition is agitated for a predetermined duration based on the initial temperature of the metal alloy composition and the heat extraction rate of the agitator.
22. An apparatus for production of a non-dendritic semi-solid metal alloy slurry from a liquid state for subsequent forming into a metal component, comprising:
a vessel for containing a metal alloy composition;
an agitator for inducing convection while rapidly cooling said metal composition to initiate solidification and forming non-dendritic solid particles in the metal alloy composition;
and
a cooling vessel for further cooling and raising the solids content of the slurry.
23. The apparatus of claim 22, wherein the cooling vessel has walls made of a material selected from steel and stainless steel.
24. The apparatus of claim 22, wherein the cooling vessel has walls made of graphite.
25. The apparatus of claim 23, wherein the internal walls of the cooling vessel are provided with a non-wetting or reduced wetting coating.
26. The apparatus of claim 25, wherein the coating is a boron nitride coating.